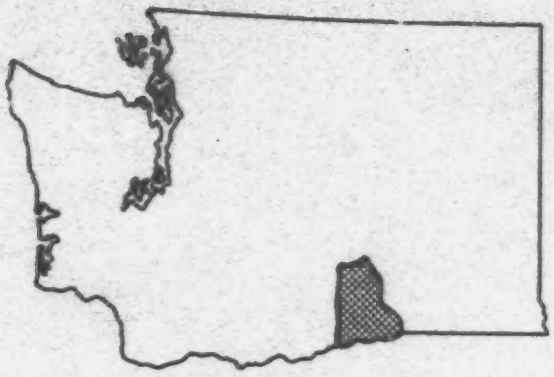
594-C-47
FEMA 209: 530237/990

# FLOOD INSURANCE STUDY

## BENTON COUNTY, WASHINGTON
## UNINCORPORATED AREAS



REVISED: MARCH 19, 1990

Federal Emergency Management Agency

COMMUNITY NUMBER-530237

## NOTICE TO
## FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

This publication incorporates revisions to the original FIS. These revisions are presented in Section 9.0.

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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

# 1.0 INTRODUCTION

## 1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the unincorporated areas of Benton County, Washington, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert the unincorporated areas of Benton County to the regular program of flood insurance by the Federal Emergency Management Agency. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain development.

## 1.2 Coordination

A meeting was held in April 1976, in the City of Prosser, with representatives of the study contractor, the Federal Emergency Management Agency, the Washington State Department of Ecology, and Benton County to discuss areas to be covered and study methods to be used.

On October 21, 1977, an intermediate coordination meeting was held at the Benton County Courthouse in Prosser to discuss the preliminary results of the study. In attendance were representatives of Benton County, the Federal Emergency Management Agency, and the study contractor. No changes were requested or made to the material presented at the meeting. Because of the recent publication of the Flood Hazard Boundary Map (Reference 1), the county requested additional time to review those maps.

On July 24, 1978, a meeting was held with the Benton County Commissioners and representatives of the Federal Emergency Management Agency to present the Flood Insurance Program and explain county responsibilities.

The U.S. Army Corps of Engineers, the U.S. Geological Survey, the U.S. Soil Conservation Service, and the U.S. Bureau of Reclamation were contacted to obtain coordinating information on stream flows and past flood data. The State of Washington Department of Ecology was also contacted for information regarding this Flood Insurance Study. Several private photograph collections were reviewed for documentation of past flooding. This coordination began at the April 1976 meeting and continued through subsequent correspondence.

The final coordination meeting was held on March 9 and 10, 1981, and was attended by representatives of the Federal Emergency Management Agency, the study contractor, and the county. No problems were raised at the meeting.

### 1.3 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by Howard Needles Tammen & Bergendoff, for the Federal Emergency Management Agency, under Contract No. H-4009. This work, which was completed in June 1979, covered all significant flooding sources affecting Benton County.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Benton County, Washington. The area of study is shown on the Vicinity Map (Figure 1). Not included in this study are the Cities of Kennewick, Richland, and Prosser, the Towns of West Richland and Benton City, and the U.S. Department of Energy Reservation.

The following streams were studied by detailed methods:

Yakima River, for approximately 16 miles, from its confluence with Columbia River to approximately 2.0 miles downstream of Horn Rapids Dam

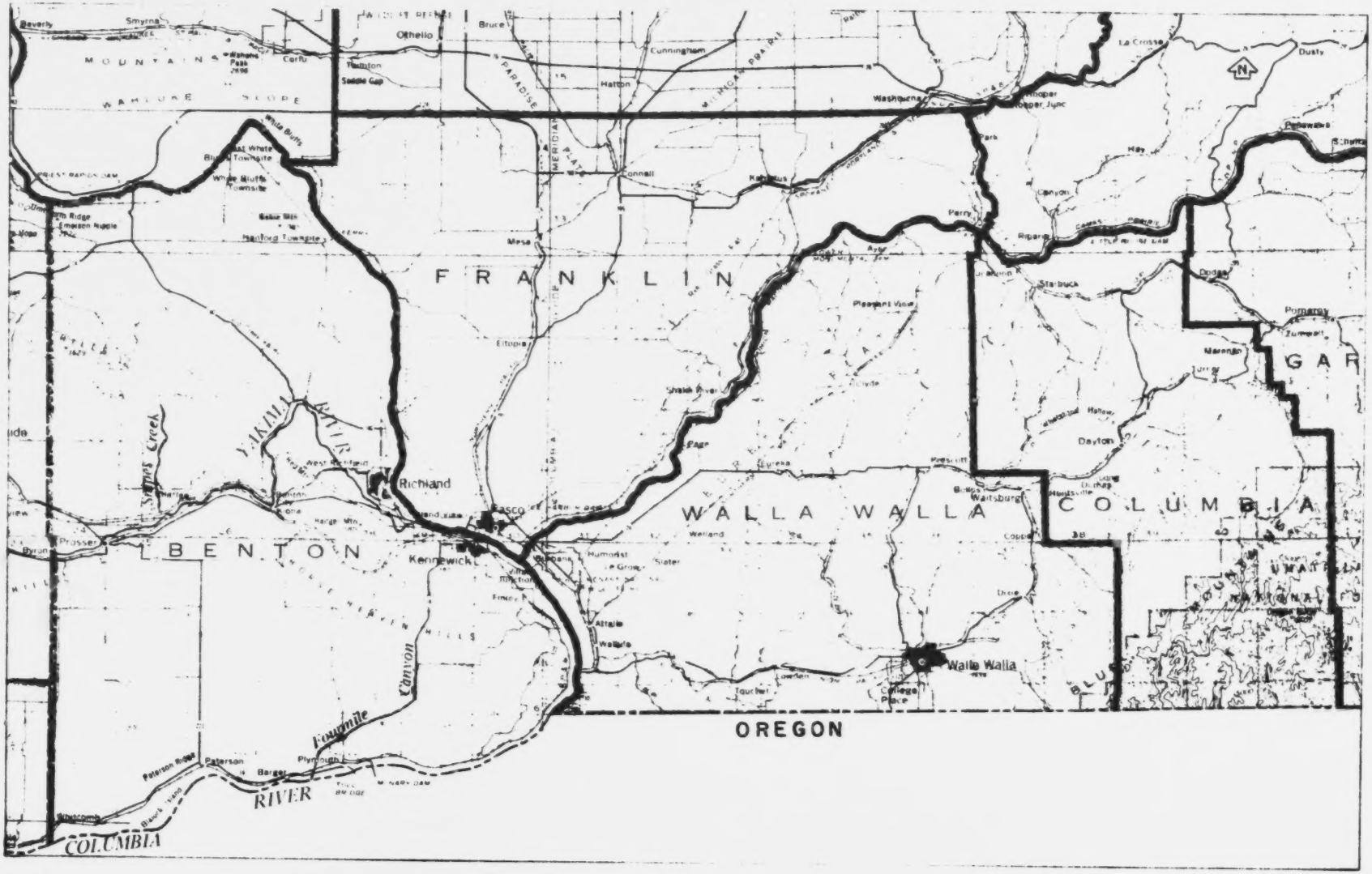
Yakima River, for approximately 11.3 miles, from approximately 5.5 miles downstream to approximately 4.0 miles upstream of Benton City

Yakima River, for approximately 8.0 miles, from approximately 2.5 miles downstream of the Washington State Highway 40 bridge at Prosser to the Benton County - Yakima County limits

Zintel Canyon, for approximately 0.4 mile along the Kennewick corporate limits between West 15th Avenue and West 19th Avenue

Kennewick Sump, from the area south of East 27th Avenue to the Columbia Irrigation District Canal

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the Federal Emergency Management Agency and Benton County.


FRANKLIN
BENTON
WALLA WALLA
COLUMBIA
OREGON
Richland
Kennewick
Pasco
Walla Walla
College Place
Othello
Connell
Dayton
Starbuck
Pomeroy
Waitsburg
Prosser
Paterson
Plymouth
Attalia
Wallula
Touchet
Dixie
Mesa
Eltopia
Pleasant View
Humorist
Slater
Finley
Burbank
Peterson Ridge
Horse Heaven Hills
YAKIMA RIVER
Snipes Creek
Rattlesnake Canyon
Fourmile Canyon
COLUMBIA RIVER
MOUNTAINS
WAHLUKE SLOPE
PALOUSE SLOPE
PARADISE MERIDIAN
WASHINGTON PRAIRIE
Washtucna
Hooper
Hooper Junc
Kahlotus
Perry
Ritzville
Lacrosse
Dusty
Pullman
Schweitzer
Hay
Canyon
Ayer
Dodge
Marengo
Zumwalt
Hatton
Cunningham
Othello
Bruce
Smyrna
Beverly
Corfu
Hamton
Saddle Gap
White Bluffs
Basin City
Hanford Townsite
Emerson Nipple
Fir Ridge
Prosser
Byron
Finley
Burbank
Wallula
Touchet
College Place
Dixie
Waitsburg
Starbuck
Dayton
Pomeroy
Zumwalt
Marengo
Hay
Canyon
Ayer
Dodge
Ritzville
Lacrosse
Dusty
Pullman
Schweitzer
Hooper
Hooper Junc
Washtucna
Kahlotus
Perry
Riparia
Pleasant View
Eltopia
Mesa
Connell

The following streams were studied by approximate methods:

Yakima River, for approximately 17.1 miles between the detailed study areas

Zintel Canyon, for approximately 2.0 miles between West 27th Avenue and West 45th Avenue, extended

Snipes Creek, for approximately 5.0 miles, from its confluence with Yakima River to 0.5 mile above Snipes Road

Nine Canyon, for approximately 0.5 mile above Finley Road to Columbia Irrigation Canal No. 3

Fourmile Canyon, for approximately 2.0 miles, from its confluence with Columbia River to Washington State Highway 14

Corral Creek, for approximately 0.5 mile, from its confluence with Yakima River

Spring Creek, for approximately 2.0 miles, from its confluence with Yakima River to McCreadie Road

Unnamed Creek, for approximately 1.5 miles, from its confluence with Yakima River to approximately 2000 feet north of Knox Road

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development through 1984.

## 2.2 Community Description

Benton County is in south-central Washington and is bordered by Klickitat County to the southwest, Yakima County to the west, Grant County to the north, Franklin County to the northeast, Walla Walla County to the east, Umatilla County, Oregon to the southeast, and Morrow County, Oregon to the south. The 1975 population in the county was 20,551 (Reference 2), which ranked 23rd among the other counties in Washington.

Agriculture and related activities were the primary sources of income in the county until the early 1960s. In 1961, manufacturing became the major source of employment in the county and contributed almost $70 million toward the personal income of county residents. In 1963, the Hanford Atomic Energy Project became the largest source of employment and continues to maintain this status. Land in Benton County that is suitable for agricultural use comprises 64 percent of the total county area. Its use is evenly distributed between cropland, rangeland, and pastureland.

Yakima River, which flows westerly to easterly bisecting the county, begins near Lake Kachess in the Cascade Range and joins Columbia River at Richland, 200 miles downstream (Reference 3).

Yakima River generally flows through agricultural lands and, except for the incorporated areas at Prosser, Benton City, West Richland, and Richland, the flood plain is sparsely settled. At Prosser, the river flows on the north side of the central business district. From Prosser to just west of Benton City, the river is confined to a canyon. At Benton City, the flood plain widens to the south and east to encompass the majority of the land between the river and the business district. Downstream of Benton City, the flood plain remains 3000 to 4000 feet wide for approximately 4 miles and then enters a narrow segment until 8 miles upstream of West Richland. At that point, the flood plain widens and remains that way to the confluence with Columbia River. Between West Richland and Richland, the river flows near both commercial and residential development.

Zintel Canyon is a small, narrow creek with its headwaters in the Horse Heaven Hills approximately 7.0 miles south of Kennewick. In its upper region, development is sparse. At Kennewick, the Canyon terminates in an alluvial fan with extensive residential development.

Snipes Creek is an intermittent stream which enters Yakima River from the north near the unincorporated community of Whitstran. Except for the lower 0.5 mile near Yakima River, the creek is confined in a narrow, steep canyon. Little development exists along the stream.

Nine Canyon is a small drainage system with a length of approximately 8.0 miles. The area is sparsely settled and the land is used primarily for agriculture. The lower 2.0-mile segment of the stream is a wide, flat alluvial fan with a barely discernible stream bed.

Fourmile Canyon drains a large area of southeastern Benton County and empties into Columbia River downstream of McNary Dam. The area being studied is sparsely settled and is primarily agricultural land.

The remaining streams studied by approximate methods as part of this report drain small basins and flow through primarily agricultural land.

The topography of Benton County generally slopes from west to east. Yakima River flows through the center one-third of the county with the Horse Heaven Hills south of the river and the Rattlesnake Hills on the north dividing the county. Columbia River forms the northern, eastern, and southern boundaries of the county.

The numerous landforms and soil associations found in Benton County are the result of a continuous transformation of the land surface by oceanic inundation, volcanic eruptions, and glaciation during the Pleistocene Epoch.

The soils along Yakima River are of the Starbuck-Scooteney and the Hezel-Quincy-Burbank Associations. These soils are silt loam and loamy sand and are shallow to very deep over gravel or bedrock. The soils in the Zintel Canyon area are of the Scooteney-Kennewick and the Finley-Burbank-Quincy Associations. These are gentle to nearly level soils formed from old alluvium, lacustrine, and windblown material (Reference 4).

The climate in Benton County is typical of eastern Washington counties and consists of dry, warm summers and mild winters. The maximum midsummer temperatures reach the low 90s while the midwinter temperatures are in the high 20s. Annual precipitation averages approximately 7.5 inches per year. Vegetation in the area is typical of the type found in sandy desert-like areas, and consists of shrubs, grasses, and scattered deciduous trees.

## 2.3 Principal Flood Problems

Periodic flooding of Yakima River and Zintel Canyon occurs under similar weather conditions. The most severe flooding occurs during the winter and spring months as a result of heavy rains and snowmelt runoff on frozen ground. In the unincorporated areas on Yakima River in the vicinity of West Richland, flooding is also caused by the simultaneous occurrence of excess runoff and ice jams (Reference 4). In the unincorporated areas near Kennewick, shallow flooding is often due to frozen, impenetrable soils. Such soil conditions prevent natural penetration of floodwaters into the soil, forcing water out of natural channels and into lowland areas.

Benton County has been subjected to flooding from overflows of Yakima River. The maximum known flood occurred in December of 1933 with a depth of approximately 9.5 feet over the river banks at Benton City. The 1933 flood has an estimated recurrence interval of approximately 170 years. Other recent major floods and their recurrence intervals occurred in 1948 (33-year) and 1974 (36-year). Other flows overtopping the river banks occurred in 1950, 1951, 1955, 1956, 1957, 1959, 1965, 1968, 1969, and 1972 and had estimated recurrence intervals of 4 years. The 1950 flood had a flood stage higher than the 1948 flood, but the height was caused by ice jams and not the volume of water. These floods were of a relatively long duration with the 1948 flood remaining out of the banks for 19 days (Reference 3).

The December 1977 flood on Yakima River had a peak flow of 29,000 cubic feet per second (cfs), and an estimated recurrence interval of 14 years. Newspaper reports in the Tri-City Herald indicate that serious flooding occurred during the winter and spring months of 1949, 1956, 1963, 1965, 1968, 1969, 1971, and 1973 and were the result of heavy rains and snowmelt in combination with ice jams.

Newspaper reports in the Tri-City Herald also document major floods on Zintel Canyon in 1949, 1952, 1956, 1959, and 1964 resulting in damage in the City of Kennewick.

Flows on Zintel Canyon are confined by the steep, narrow canyon from its headwaters to the vicinity of West 10th Avenue in Kennewick, where the canyon begins to widen into a flat, alluvial fan with no defined stream channel. Near West 7th Avenue and Rainier Street in Kennewick, the Zintel Canyon floodflows split with part of the flow going north along Rainier Street to Columbia River and the remainder flowing southeast to a low point southeast of East 27th and Gum Streets.

## 2.4 Flood Protection Measures

While there are a number of reservoirs located in the upper lengths of the Yakima River basin and it is felt that these reservoirs have had some beneficial effects by reducing the impact of flooding, there are no flood control measures in operation or planned in the vicinity of Benton City or Prosser.

Flood protection measures in the form of levees have been constructed on Yakima River to prevent or control the overflow and backwater from Columbia River. The water-surface elevations on Columbia River are controlled farther downstream at McNary Dam. The levees are located on both banks of Yakima River near its mouth in the City of Richland. Additionally, a levee has been constructed along the south bank for approximately 1.0 mile downstream of the Van Giesen Street bridge. These levees will contain the 500-year flood.

There are no flood protection measures in operation on Zintel Canyon. Preliminary investigation of a project which would handle the 100-year flows was made by the U.S. Army Corps of Engineers, Walla Walla District, but, lacking local sponsorship and contributions, the project was dropped, as reported to the study contractor during a meeting with the Kennewick City Manager on April 6, 1977.

The State of Washington has set up flood patrol zones along the major rivers in Benton County. Flood plain development within these zones is regulated through building permits issued by the State Department of Ecology.

# 3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-,

100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual occurrence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported here reflect flooding potentials based on conditions existing in the county at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

## 3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each stream studied in detail in the county.

Hydrologic information for Yakima River was supplied by the U.S. Army Corps of Engineers (Reference 5). The data supplied were based on a gaging station located in Benton City, which has recorded flows for 64 years. The 500-year peak discharge was obtained by extrapolating from a frequency curve plotted for calculated peak discharges.

There is no stream gaging station located on Zintel Canyon. Values of 10-, 50-, and 100-year peak discharges were obtained from a log-Pearson Type III distribution using the computer program FREQFLO (Reference 6). These values were compared with the results obtained from regional relationships and were adjusted using average factors derived from the gage stations in the areas having similar characteristics (References 7, 8, 9, 10, 11, 12, 13, and 14). The 500-year peak discharge was obtained by extrapolating a frequency curve plotted for calculated peak discharges.

Peak discharge-drainage area relationships for Yakima River and Zintel Canyon are shown in Table 1.

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of streams in the county were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each stream studied in the county.

For Yakima River, cross section data for the areas studied in detail in the vicinities of Benton City and Prosser were obtained from previous field measurements (Reference 3), and supplemented by field inspection. Due to the use of established river miles, stream distances as shown on the flood profiles may not always match those depicted on the maps. New field surveys were taken for the area from Columbia River to approximately 2 miles downstream of the Horn Rapids Dam.

Table 1. Summary of Discharges

| Flooding Source and Location | Drainage Area (Square Miles) | Peak Discharges (cfs) 10-Year | 50-Year | 100-Year | 500-Year |
|---|---|---|---|---|---|
| Yakima River | | | | | |
| At Benton City | 6150 | 26,100 | 44,000 | 55,500 | 97,000 |
| Zintel Canyon | | | | | |
| At Mouth | 21 | 390 | 1,310 | 1,920 | 4,000 |
| Kennewick Sump | | | | | |
| At Intersection of 19th Avenue and Beech Street | 29.1 | N/A | N/A | 1,900 | N/A |

For Zintel Canyon north of West 27th Avenue, cross section data were obtained by field measurements supplemented by information from topographic maps (References 15 and 16). For the Kennewick Sump area, southeast of Kennewick, contour maps were obtained from Columbia Irrigation District (Reference 17).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Elevation data and structural geometry for all bridges were obtained from field surveys and bridge plans in order to compute the significant backwater effects of these structures.

Roughness coefficients (Manning's "n") were estimated by field inspection of the streams and flood plains (Reference 18). The following list shows the range of roughness values for the channel and for the overbank areas. The values depend upon location.

| Flooding Source and Location | Roughness Values | |
|---|---|---|
| | Channel Area | Overbank Area |
| Yakima River | | |
| From Richland to Horn Rapids Dam | 0.035-0.040 | 0.030-0.035 |
| At Benton City | 0.035-0.050 | 0.030-0.045 |
| At Prosser | 0.025-0.060 | 0.025-0.045 |
| Zintel Canyon | 0.070 | 0.070 |

In the area near West Richland, the distribution of flow between the main channel and right overbank of the Yakima River was determined in accordance with the procedure outlined in Hydraulic Engineering Methods for Water Resources Development (Reference 19). The water-surface elevations for both flow paths were determined independently.

Water-surface elevations for the 10-, 50-, 100-, and 500-year floods were developed for the areas studied by detailed methods using a U.S. Army Corps of Engineers HEC-2 computer step-backwater model (References 20 and 21). Starting water-surface elevations for the hydraulic computations for Yakima River and Zintel Canyon were determined using the slope-area method at a point downstream of the area being studied.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

For the segments of Yakima River not studied by detailed methods, the elevations were determined from a previous study (Reference 3).

Elevations of other flooding sources studied by approximate methods were determined by field inspection, engineering judgment, and local accounts of flooding.

Elevations in the Kennewick Sump area were determined using the slope-area method in conjunction with U.S. Soil Conservation Service unit hydrograph method (Reference 22).

A profile baseline for the right overbank of Yakima River was incorporated into this study in the divided flow area near West Richland.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in the study are shown on the maps.

## 4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage State and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

### 4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at scales of 1:1,200, with a contour interval of 2 feet (References 23, 24, and 25), 1:2,400 with a contour interval of 5 feet (Reference 26), 1:24,000 with a contour interval of 10 feet (Reference 15), and 1:62,500 with a contour interval of 20 feet (Reference 16).

Flood boundaries for those streams studied by approximate methods were delineated using topographic maps at scales of 1:24,000 and 1:62,500 with contour intervals of 10 feet and 40 feet, respectively, in conjunction with previously estimated elevations (References 15 and 16).

Flood boundaries for the Kennewick Sump area were delineated using topographic maps at scales of 1:24,000 and 1:62,500 with contour intervals of 10 feet and 40 feet, respectively, in conjunction with previously determined elevations (References 15 and 16).

Approximate flood boundaries in some portions of the study area were taken from the Flood Hazard Boundary Map (Reference 1).

Flood boundaries for the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year flood boundary has been shown. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

## 4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity and increases flood heights, thus increasing flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment in order that the 100-year flood be carried without substantial increases in flood heights. As minimum standards, the Federal Emergency Management Agency limits such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced.

The floodways for this study were computed on the basis of equal-conveyance reduction from each side of the flood plain. In the West Richland area separate floodways for the main channel and the right overbank were determined so that the total energy loss was the same for both flow paths. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

Since the concept of a floodway does not apply to areas of shallow flooding, no floodway was computed for the Kennewick Sump area.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood boundaries are close together, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Yakima River - Right Overbank | | | | | | | | |
| F | 0.317[1] | 1,285[2] | 7,304 | 2.1 | 375.6 | 375.6 | 376.1 | 0.5 |
| G | 0.665[1] | 2320/250[3] | 3,899 | 3.9 | 376.5 | 376.5 | 377.2 | 0.7 |
| H | 0.950[1] | 565 | 2,602 | 5.9 | 380.4 | 380.4 | 380.8 | 0.4 |
| K | 1.135[1] | 967 | 3,467 | 4.4 | 383.0 | 383.0 | 383.9 | 0.9 |
| Zintel Canyon | | | | | | | | |
| A | 2.12[4] | 110/55[3] | 479 | 4.0 | 504.0 | 504.0 | 504.9 | 0.9 |

[1]Miles Above Convergence With Main Channel [2]Floodway Located Entirely Outside Study Area
[3]Width/Width Within Study Area [4]Miles Above Mouth

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**

**YAKIMA RIVER-RIGHT OVERBANK-ZINTEL CANYON**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE [1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Yakima River | | | | | | | | |
| A | 4.053 | 730/150 [2] | 8,366 | 6.6 | 356.2 | 356.2 | 357.0 | 0.8 |
| B | 4.583 | 730/530 [2] | 8,510 | 6.5 | 359.0 | 359.0 | 359.7 | 0.7 |
| C | 6.286 | 1,720/180 [2] | 13,612 | 4.1 | 365.1 | 365.1 | 365.5 | 0.4 |
| D | 6.666 | 2,270/300 [2] | 14,290 | 3.9 | 365.8 | 365.8 | 366.6 | 0.8 |
| E | 7.083 | 3,560/110 [2] | 16,115 | 3.4 | 366.9 | 366.9 | 367.5 | 0.6 |
| F | 9.150 | 1,870/360 [2] | 14,729 | 2.7 | 376.2 | 376.2 | 376.6 | 0.4 |
| G | 9.697 | 2,521/2,340 [2] | 19,791 | 2.0 | 376.9 | 376.9 | 377.3 | 0.4 |
| H | 10.032 | 2,308 | 5,951 | 6.8 | 376.9 | 376.9 | 377.4 | 0.5 |
| I | 10.606 | 906/800 [2] | 6,925 | 5.8 | 382.5 | 382.5 | 383.3 | 0.8 |
| J | 11.086 | 4,929 | 24,205 | 1.7 | 383.8 | 383.8 | 384.8 | 1.0 |
| K | 11.636 | 5,450 | 30,511 | 1.3 | 384.2 | 384.2 | 385.0 | 0.8 |
| L | 11.986 | 5,510 | 27,889 | 2.0 | 385.2 | 385.2 | 385.9 | 0.7 |
| M | 13.287 | 3,800 | 18,070 | 3.1 | 392.0 | 392.0 | 392.4 | 0.4 |
| N | 13.429 | 3,600 | 13,470 | 4.1 | 392.3 | 392.3 | 392.7 | 0.4 |
| O | 14.187 | 3,520 | 19,091 | 2.9 | 393.9 | 393.9 | 394.5 | 0.6 |
| P | 16.015 | 636 | 8,530 | 6.5 | 409.3 | 409.3 | 409.3 | 0.0 |
| Q | 23.130 | 400/335 [2] | 4,091 | 13.6 | 446.3 | 446.3 | 447.1 | 0.8 |
| R | 24.230 | 530 | 7,438 | 7.5 | 449.4 | 449.4 | 450.1 | 0.7 |
| S | 25.120 | 1,197 | 9,584 | 5.8 | 453.0 | 453.0 | 454.0 | 1.0 |
| T | 26.090 | 462 | 6,569 | 8.4 | 457.1 | 457.1 | 457.9 | 0.8 |
| U | 26.960 | 1,086 | 8,273 | 6.7 | 461.7 | 461.7 | 462.6 | 0.9 |
| V | 27.720 | 1,020 | 9,866 | 5.6 | 464.6 | 464.6 | 465.5 | 0.9 |

[1] Miles Above Confluence With Columbia River

[2] Width/Width Within Study Area

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**

**YAKIMA RIVER**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE [1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Yakima River (Cont'd) | | | | | | | | |
| W | 28.530 | 719/600 [2] | 8,304 | 6.7 | 468.3 | 468.3 | 469.0 | 0.7 |
| X | 29.820 | 1,335/385 [2] | 13,088 | 4.2 | 473.8 | 473.8 | 474.3 | 0.5 |
| Y | 30.770 | 440 | 4,161 | 13.3 | 475.8 | 475.8 | 476.7 | 0.9 |
| Z | 31.620 | 756 | 9,693 | 5.7 | 486.8 | 486.8 | 487.3 | 0.5 |
| AA | 32.340 | 640 | 13,446 | 4.1 | 488.7 | 488.7 | 489.5 | 0.8 |
| AB | 33.380 | 470 | 6,058 | 9.2 | 491.4 | 491.4 | 492.2 | 0.8 |
| AC | 34.370 | 453 | 7,140 | 7.8 | 499.9 | 499.9 | 500.8 | 0.9 |
| AD | 44.760 | 470 | 7,687 | 7.2 | 600.3 | 600.3 | 601.1 | 0.8 |
| AE | 45.550 | 450 | 6,549 | 8.5 | 610.4 | 610.4 | 611.2 | 0.8 |
| AF | 46.430 | 560 | 6,798 | 8.2 | 619.3 | 619.3 | 619.6 | 0.3 |
| AG | 47.040 | 510/450 [2] | 6,331 | 8.8 | 629.3 | 629.3 | 629.5 | 0.2 |
| AH | 48.270 | 669/580 [2] | 10,473 | 5.3 | 645.9 | 645.9 | 645.9 | 0.0 |
| AI | 49.230 | 440 | 8,560 | 6.5 | 647.2 | 647.2 | 647.2 | 0.0 |
| AJ | 50.260 | 580 | 10,752 | 5.2 | 648.6 | 648.6 | 648.7 | 0.1 |
| AK | 51.190 | 630 | 11,509 | 4.8 | 649.6 | 649.6 | 649.6 | 0.0 |
| AL | 51.980 | 530 | 9,699 | 5.7 | 650.4 | 650.4 | 650.4 | 0.0 |

[1] Miles Above Confluence With Columbia River [2] Width/Width Within Study Area

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**

**YAKIMA RIVER**

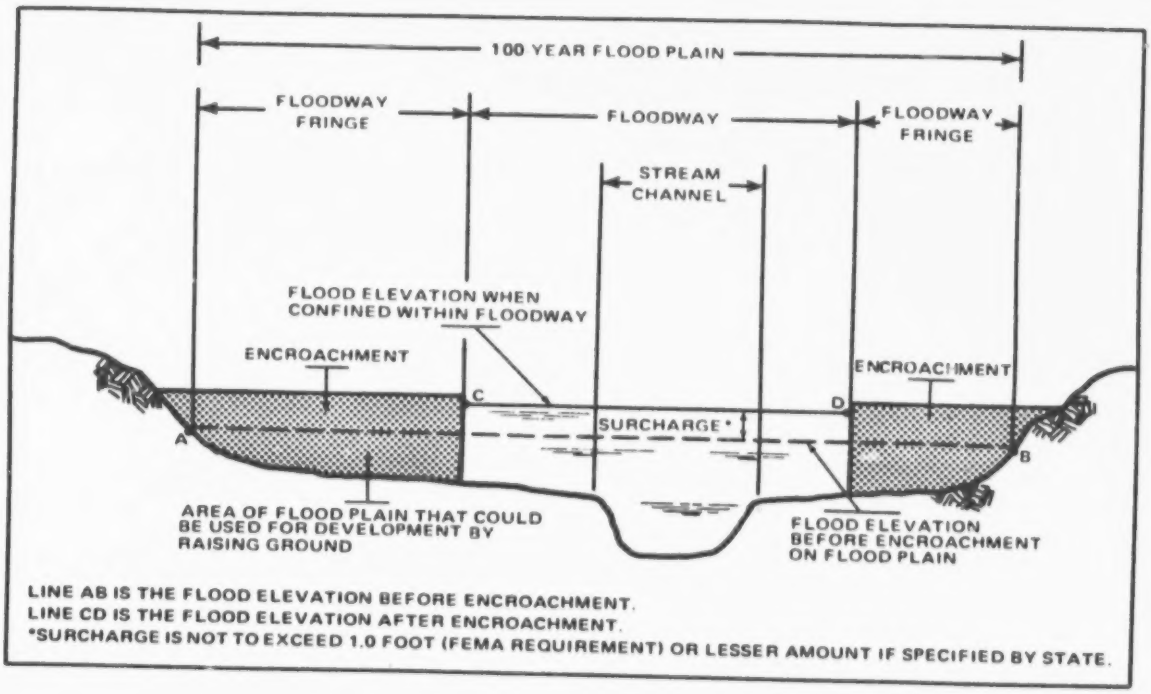

100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

Figure 2. Floodway Schematic

## 5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Emergency Management Agency has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting Benton County.

### 5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

| Average Difference Between 10- and 100-Year Floods | Variation |
|---|---|
| Less than 2 feet | 0.5 foot |
| 2 to 7 feet | 1.0 foot |
| 7.1 to 12 feet | 2.0 feet |
| More than 12 feet | 3.0 feet |

The locations of the reaches determined for the flooding sources of Benton County are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

## 5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the Federal Emergency Management Agency device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

## 5.3 Flood Insurance Zones

After the determination of reaches and their respective Flood Hazard Factors, the unincorporated areas of Benton County were divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

| | |
|---|---|
| Zone A: | Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or Flood Hazard Factors determined. |
| Zone AH: | Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no Flood Hazard Factors are determined. |
| Zones A4, A7, A8, A10, and A12: | Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to Flood Hazard Factors. |

| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION (FEET NGVD)[3] |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| Yakima River | | | | | | | |
| Reach 1 | 0465,0470 | | | | | | |
| | 0605 | -4.9 | -1.5 | 3.9 | 050 | A10 | Varies - See Map |
| Reach 2 | 0455,0465 | -3.4 | -1.0 | 2.1 | 035 | A7 | Varies - See Map |
| Reach 3 | 0455,0465 | -2.2 | -0.6 | 1.2 | 020 | A4 | Varies - See Map |
| Reach 4 | 0435,0455 | | | | | | |
| | 0465 | -4.0 | -1.2 | 2.6 | 040 | A8 | Varies - See Map |
| Reach 5 | 0420,0430 | | | | | | |
| | 0440 | -4.2 | -1.3 | 3.8 | 040 | A8 | Varies - See Map |
| Reach 6 | 0420 | -6.0 | -1.9 | 5.0 | 060 | A12 | Varies - See Map |
| Reach 7 | 0480,0485 | | | | | | |
| | 0505 | -5.2 | -1.8 | 5.2 | 050 | A10 | Varies - See Map |
| Yakima River - Right Overbank | | | | | | | |
| Reach 1 | 0465 | -1.8 | -0.7 | 1.4 | 020 | A4 | Varies - See Map |
| Zintel Canyon | | | | | | | |
| Reach 1 | 0609 | -2.1 | -0.8 | 1.7 | 020 | A4 | Varies - See Map |
| Kennewick Sump | | | | | | | |
| Shallow Flooding | 0628,0629 | | | | | | |
| | 0636,0637 | N/A | N/A | N/A | N/A | AH | Varies - See Map |

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
**(UNINCORPORATED AREAS)**

**FLOOD INSURANCE ZONE DATA**

**YAKIMA RIVER-YAKIMA RIVER-RIGHT OVERBANK-ZINTEL CANYON-KENNEWICK SUMP**

| | |
|---|---|
| Zone B: | Areas between the Special Flood Hazard Areas and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided. |
| Zone C: | Areas of minimal flooding. |
| Zone D: | Areas of undetermined, but possible flood hazard. |

The flood elevation differences, Flood Hazard Factors, flood insurance zones, and base flood elevations for each flooding source studied in detail in the county are summarized in Table 3.

### 5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Benton County is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Emergency Management Agency.

## 6.0 OTHER STUDIES

Under an initial identification date of August 9, 1977, a Flood Hazard Boundary Map for Benton County (Reference 1) was published. Because the Yakima River flood plain has a fairly flat cross section with steep sides, this study agrees closely with the Flood Hazard Boundary Map as to the limits of flooding. The differences can be attributed to the type and extent of analysis and to the accuracy of mapping materials used in the two studies. The Flood Hazard Boundary Map also shows the flood boundary for Columbia River. Columbia River was not included in the scope of this study.

A Flood Plain Information report was published by the U.S. Army Corps of Engineers in 1963, covering approximately 3 miles of the Yakima River flood plain at Richland (Reference 27). Because of the steep sides of the flood plain in this area, this study agrees with the 1963 study in the extent of flooding.

The U.S. Army Corps of Engineers, Seattle District, completed a report in 1968 describing the flood situation along Yakima River in Prosser, Benton City, and West Richland (Reference 24). The study was requested by the Washington State Department of Water Resources to "aid in the solution of local flood problems and to determine the best utilization of land subject to overflow" (Reference 3). Although the study did not provide plans for the solutions to flood problems, it did provide a basis for further study by city and county offices. Because of the steep side of the flood plain in this area, this study closely follows the limits of flooding described in the 1968 study.

Flood Insurance Studies for the Cities of Richland (Reference 28), Kenewick (Reference 29), and Prosser (Reference 30), the Towns of Benton City (Reference 31) and West Richland (Reference 32), and the unincorporated areas of Franklin County, Washington (Reference 33), Umatilla County, Oregon (Reference 34), Klickitat County, Washington (Reference 35), and Morrow County, Oregon (Reference 36) have been completed and are in agreement with the results of this study. A Flood Insurance Study for the unincorporated areas of Yakima County, Washington (Reference 37) is in progress and will be in complete agreement with the results of this study.

This study is authoritative for the purposes of the National Flood Insurance Program; data presented herein either supersede or are compatible with all previous determinations.

## 7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Federal Regional Center, 130 228th Street, SW., Bothell, Washington 98011.

## 8.0 BIBLIOGRAPHY AND REFERENCES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## 9.0 REVISIONS DESCRIPTION

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data located at the Benton County Planning Department, 620 Market Street, Prosser, Washington 99350.

### 9.1 First Revision

This study was revised on March 19, 1990, to incorporate the effects of revised hydrologic and hydraulic analyses for a reach of Zintel Canyon extending from the intersection of 7th and Vancouver Streets in the City of Kennewick, Washington, to the Kennewick Sump area in Benton County, Washington. The revised analyses were prepared by the U.S. Army Corps of Engineers, Walla Walla District, as part of the study done for the City of Kennewick, Washington, under the Limited Map Maintenance Program.

The hydrologic analyses were carried out to establish the peak discharge-frequency relationships for a flood having a 100-year recurrence interval along Zintel Canyon downstream to the Kennewick Sump area. There are no stream gaging stations located in the study area. Therefore, all floodflow-frequency relationships were derived analytically using available precipitation, soil, and snow data, and available data from previous floods experienced in the area, in order to develop all frequency curves. Regional relationships were also examined to compare the derived curves with similar watersheds in the area having gaged data available. The entire study area is subject to two different types of floods, which are: (1) general rainstorm floods, and (2) thunderstorm floods. General rainstorm floods may occur with or without snowmelt, generally produce a relatively low discharge and large runoff volumes, and have a longer duration of flooding, approximately 1 to 3 days. Thunderstorm floods may have extremely high peak discharges, relatively small runoff volumes, and shorter durations of flooding, generally less than 6 hours. All general rainstorm floods analyzed were developed using the HEC-1 hydrologic model and all thunderstorm floods were developed using the Streamflow Synthesis and Reservoir Regulation (SSARR) model. Since the topsoils in the area are generally easily erodible, sedimentation effects were also considered in all analyses. The general rain and thunderstorm flood-frequency curves were combined analytically to give a composite frequency curve, which was used for the hydraulic analyses. Table 1 summarizes peak discharge and drainage area relationships for the study area.

Analyses of the hydraulic characteristics of the study area were carried out to provide estimates of the elevations of floods of the 100-year recurrence interval along Zintel Canyon downstream to the Kennewick

Sump area. Cross section data were obtained by field measurement and supplemented by U.S. Geological Survey topographic mapping, U.S. Army Corps of Engineers, Walla Walla District mapping, City of Kennewick mapping, and Columbia Irrigation District mapping.

Water-surface elevations were computed for areas from the Kennewick Sump upstream to the intersection of 7th Avenue and Vancouver Street in Kennewick, using a series of HEC-2 steady state step-backwater computer models. Water-surface elevations were determined for the 100-year composite flood along each study reach. The Kennewick Sump pool elevation occurring at the time of the peak inflow rate to the Sump was used for the starting water-surface elevation for the backwater model extending from the Kennewick Sump upstream to the Columbia Irrigation District crossing. The pool elevation and time of occurrence were determined from the HEC-1 routing model of the Kennewick Sump and contributing drainage basins.

Immediately east of the 23rd Avenue and Cedar Street intersection is an approximate transition point between overland flow conditions appropriately modeled by step-backwater methods (HEC-2 models) and ponding conditions found in the Kennewick Sump, appropriately modeled by storage and routing methods (HEC-1 models). West (upstream) of this intersection, overland flow conditions produce the maximum water-surface elevations, and east (downstream) of this intersection, ponding conditions, caused by the inability of inflowing water to exit the Kennewick Sump, produce the maximum water-surface elevations.

Water may eventually exit the Kennewick Sump through two different locations once the Sump's water-surface elevation exceeds the minimum ground elevation at either of the two locations. One location is north of 19th Avenue, between Gum and Oak Streets, where the minimum ground elevation is approximately 368 feet above Mean Sea Level (MSL). The other location is southeast of Oak Street, where the minimum ground elevation is approximately 369 feet above MSL.

Some portions of the study area are susceptible to relatively uniform shallow flooding caused by overland flow conditions, and characterized by 100-year flooding depths less than 3feet. Other areas, such as in the Kennewick Sump immediately west of the intersection of 23rd Avenue and Oak Street, are flooded by ponding to depths of approximately 10 feet during the 100-year flood. The percentage of the Kennewick Sump which is flooded by ponding to depths greater than 5 feet is relatively low, and is approximately 15 percent of the total sump area flooded by the 100-year composite flood. The remaining 85 percent of the Sump's flooded area is flooded by less than 5 feet of water. The Sump's deepest flood waters will generally be located in several discontinuous local ponding areas located adjacent to and west of Oak Street and south of 27th Avenue.

For the Kennewick Sump area the best available mapping was Columbia Irrigation District mapping at a scale of 1:2,400 and a contour interval of 5 feet. The U.S. Geological Survey mapping used as the base mapping, at a contour interval of 10 feet, occasionally was in disagreement with the mapping, having small contour intervals. In these instances, the flood boundaries were drawn in conflict with the U.S. Geological Survey contour lines and used the information found on the maps having the smaller contour interval.

The revised floodplain boundaries were delineated on a workmap submitted by the U.S. Army Corps of Engineers entitled "Kennewick-Benton County, Washington, Zintel Canyon-Kennewick Sump Flood Insurance Study Workmap," dated March 25, 1988. The boundary of the 100-year flood has been delineated using the flood elevations determined at each cross section; between cross sections the boundaries were interpolated using the best available mapping and drawn onto base maps derived from the U.S. Geological Survey topographic maps at a scale of 1:24,000 and a contour interval of 10 feet. The 1:24,000 scale was expanded to provide a base map scale of 1"=400'. The results of the revised analysis are as follows:

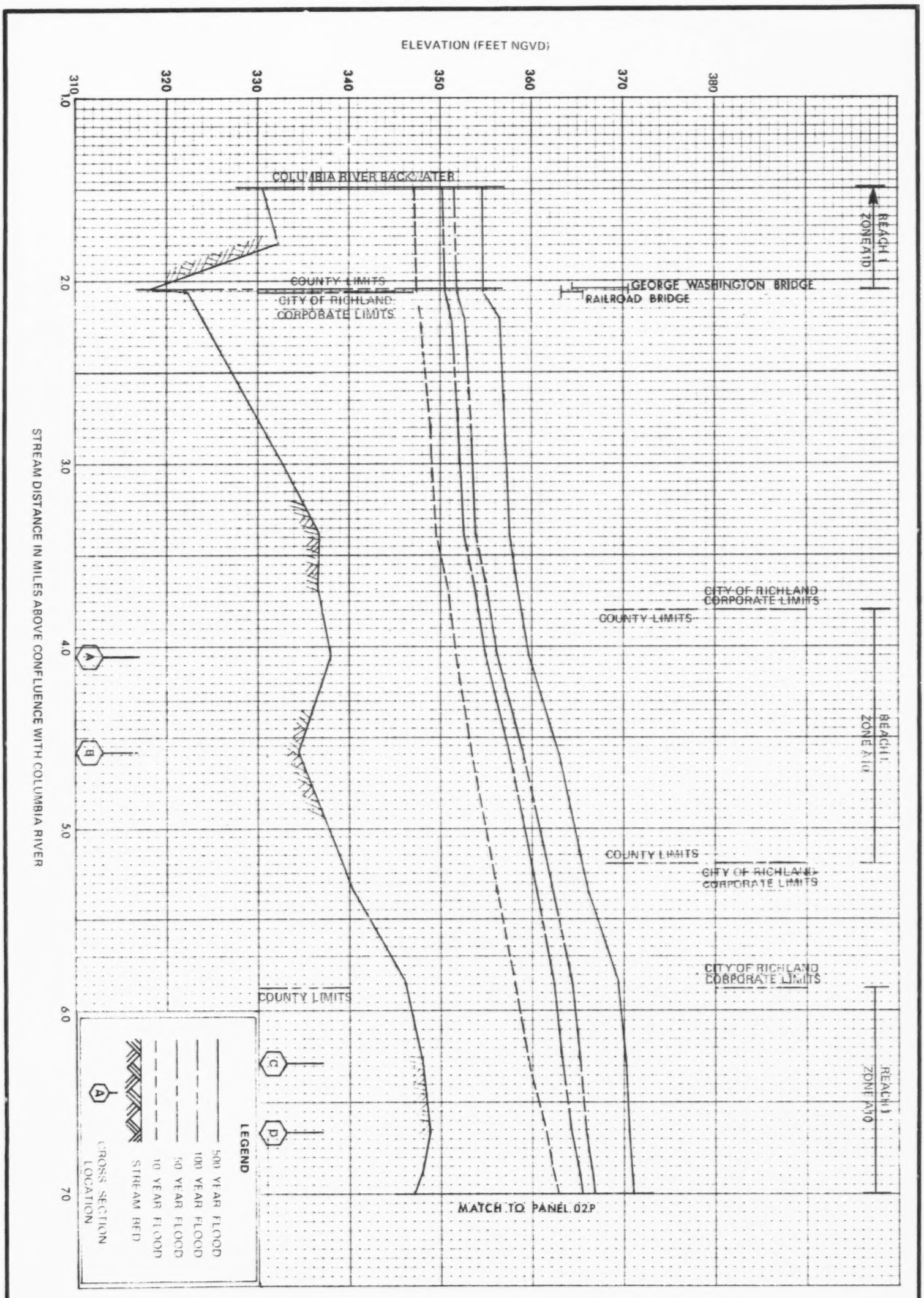
- The Special Flood Hazard Area extending northwest from South Oak Street to the intersection of South Gum Street and East 13th Avenue was revised from Zone AH to Zone B as shown on the Benton County Flood Insurance Rate Map Panel 0628 C. This Special Flood Hazard Area was determined to be an area of localized ponding with a drainage area of less than 1 square mile.

- The base flood elevations in the Special Flood Hazard Area extending southeast from East 19th Avenue, adjacent to the Kennewick corporate limits, have been lowered approximately 2 feet as shown on Flood Insurance Rate Map Panel 0628.

- The 100-year composite ponding elevation computed for the Kennewick Sump is 366.3 feet above MSL, which is approximately 2 feet lower than previously computed. The Kennewick Sump 100-year floodplain generally has the same shape as previously delineated but is not as extensive due to the lower ponding elevation computed. This is shown on Flood Insurance Rate Map Panels 0628, 0629, 0636, and 0637.

The county boundaries have been revised to reflect recent annexations by the City of Kennewick, Washington.

FIRM Panels 0628, 0629, 0636, and 0637 have been revised to reflect the aforementioned modifications. The Summary of Discharges Table has also been revised to reflect the effect of the revised hydrologic and hydraulic analyses.



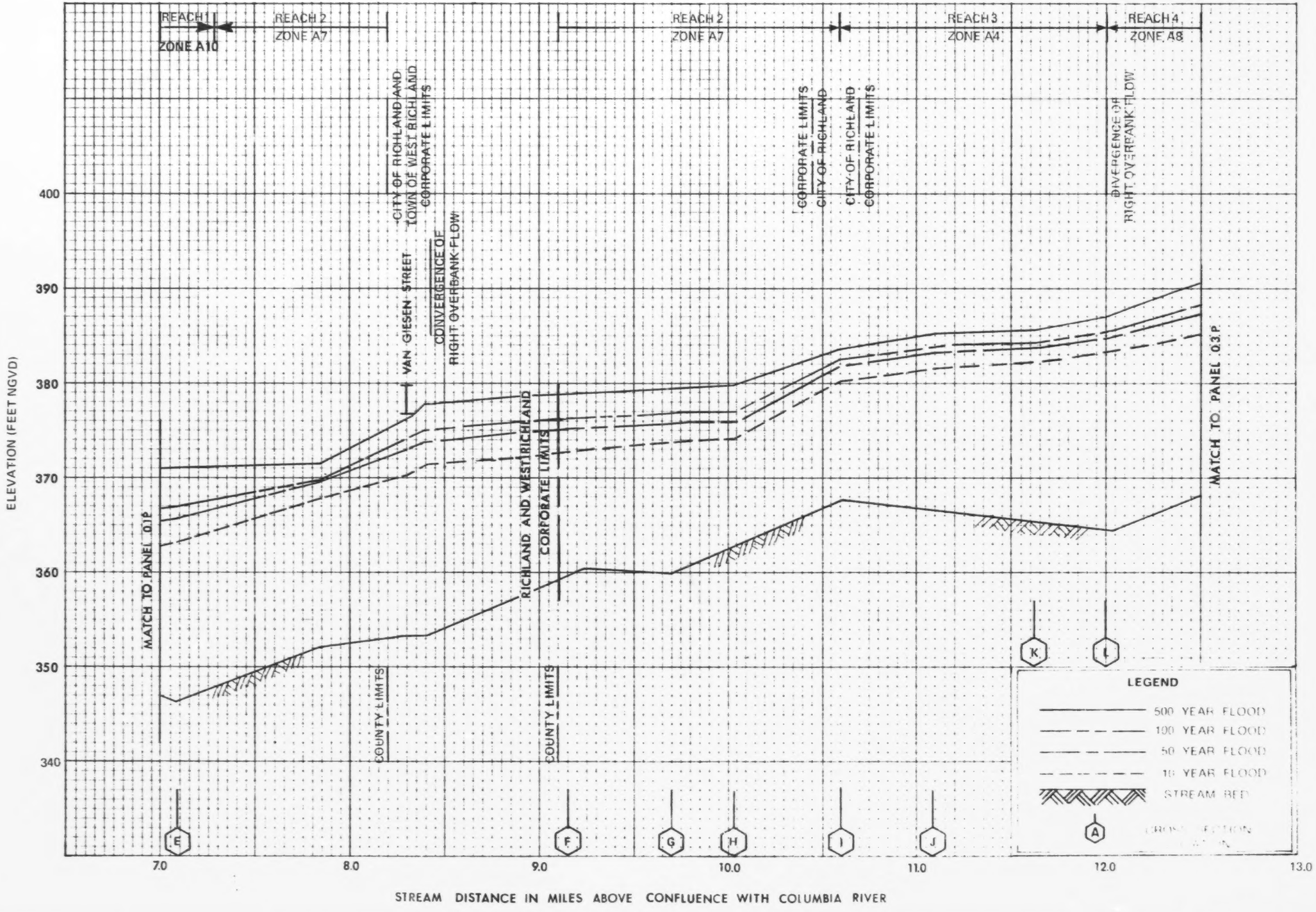

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
(UNINCORPORATED AREAS)

**FLOOD PROFILES**

YAKIMA RIVER

01P



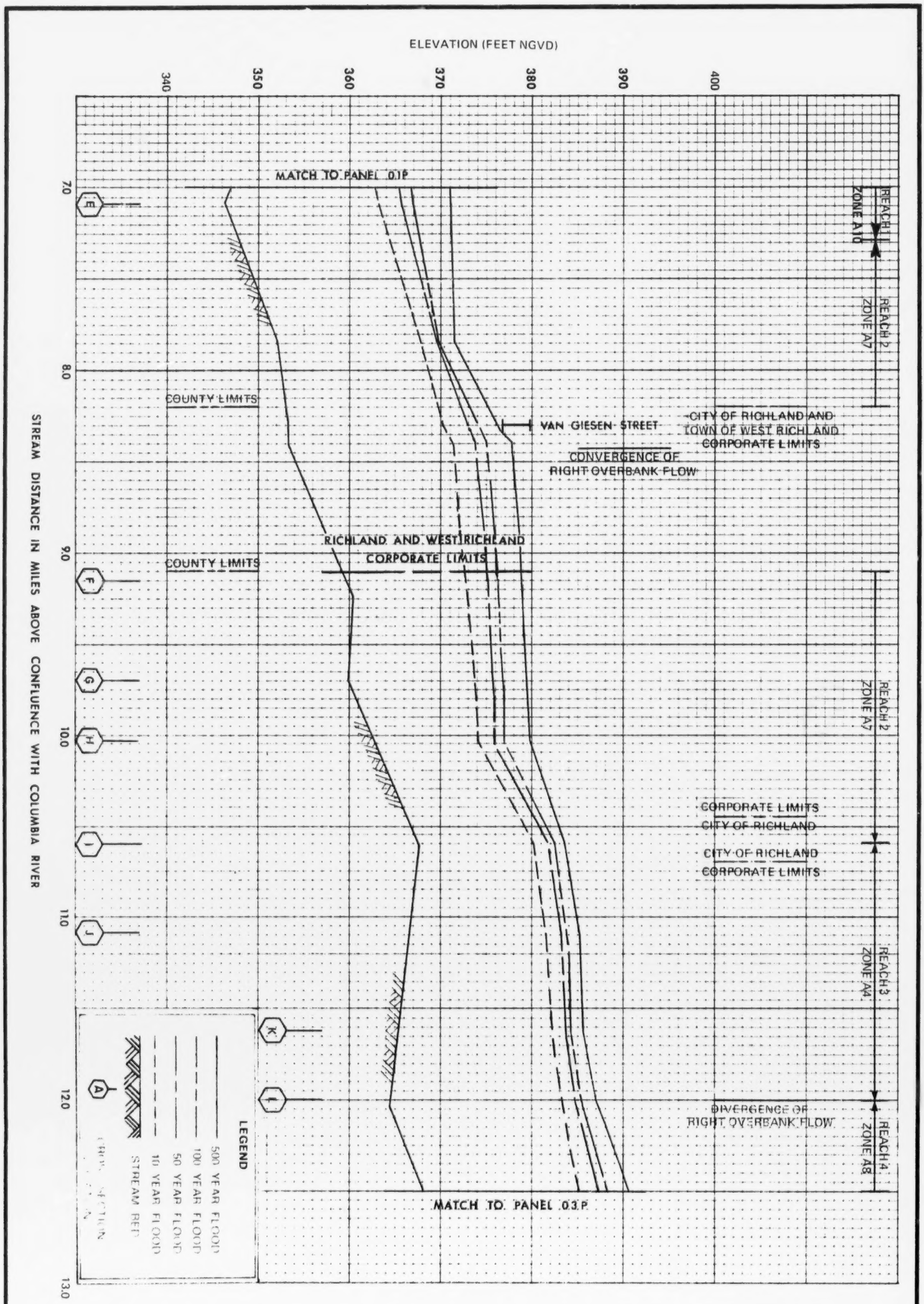

**FLOOD PROFILES**

**YAKIMA RIVER**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
(UNINCORPORATED AREAS)

**02P**



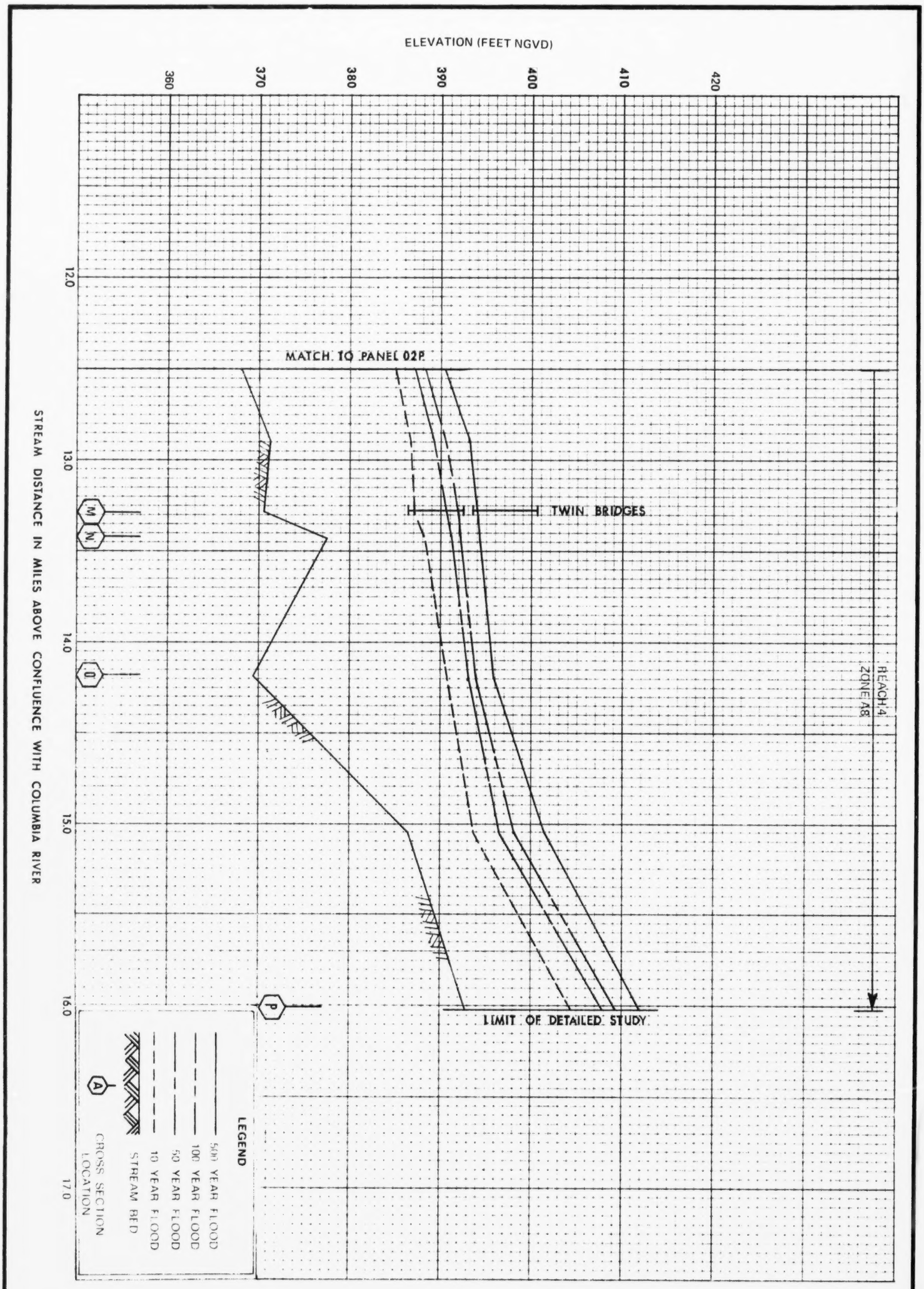

02P

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
(UNINCORPORATED AREAS)

**FLOOD PROFILES**

**YAKIMA RIVER**

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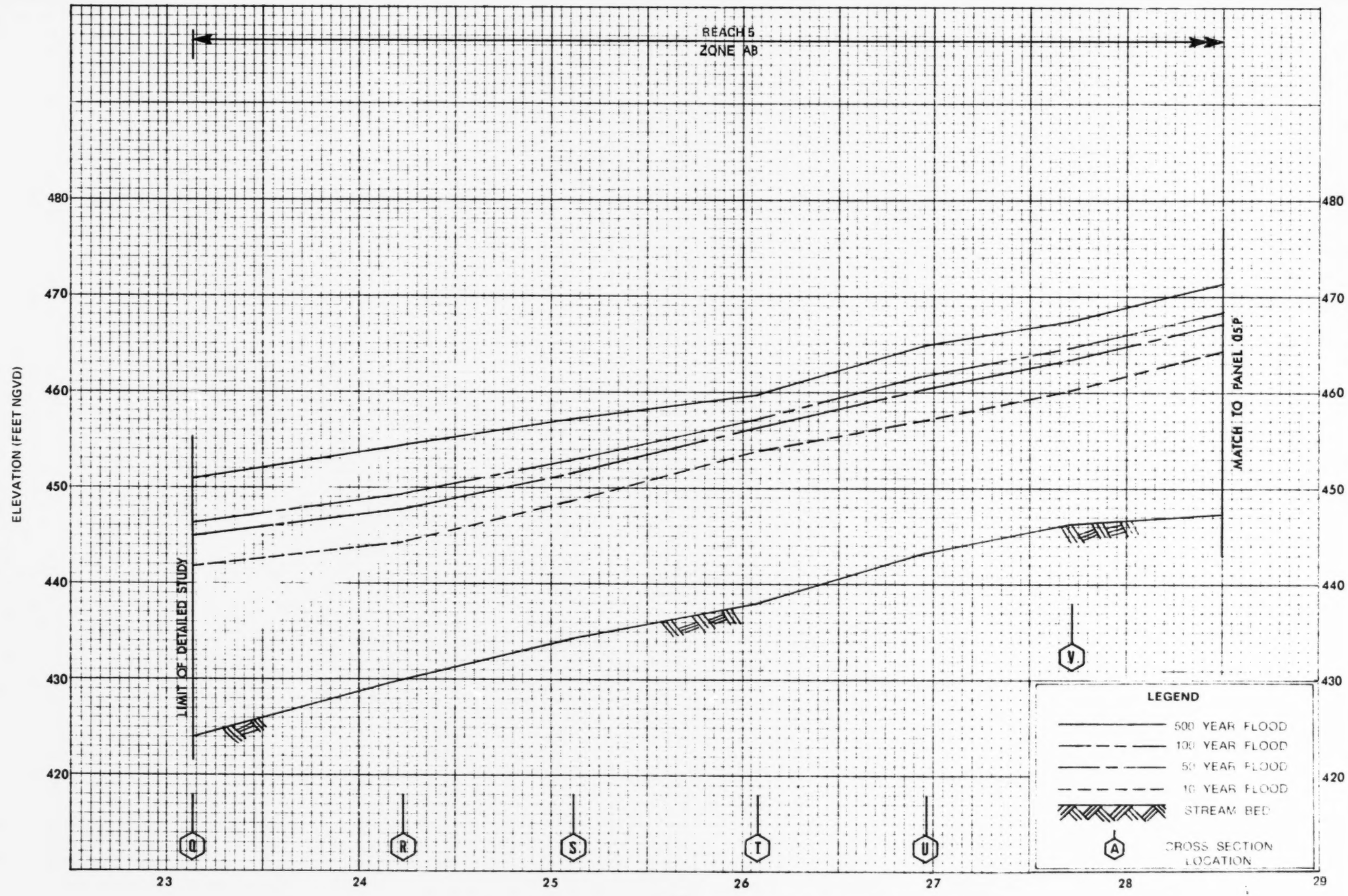
FEDERAL EMERGENCY MANAGEMENT AGENCY

03P

**BENTON COUNTY, WA**
(UNINCORPORATED AREAS)

**FLOOD PROFILES**

**YAKIMA RIVER**

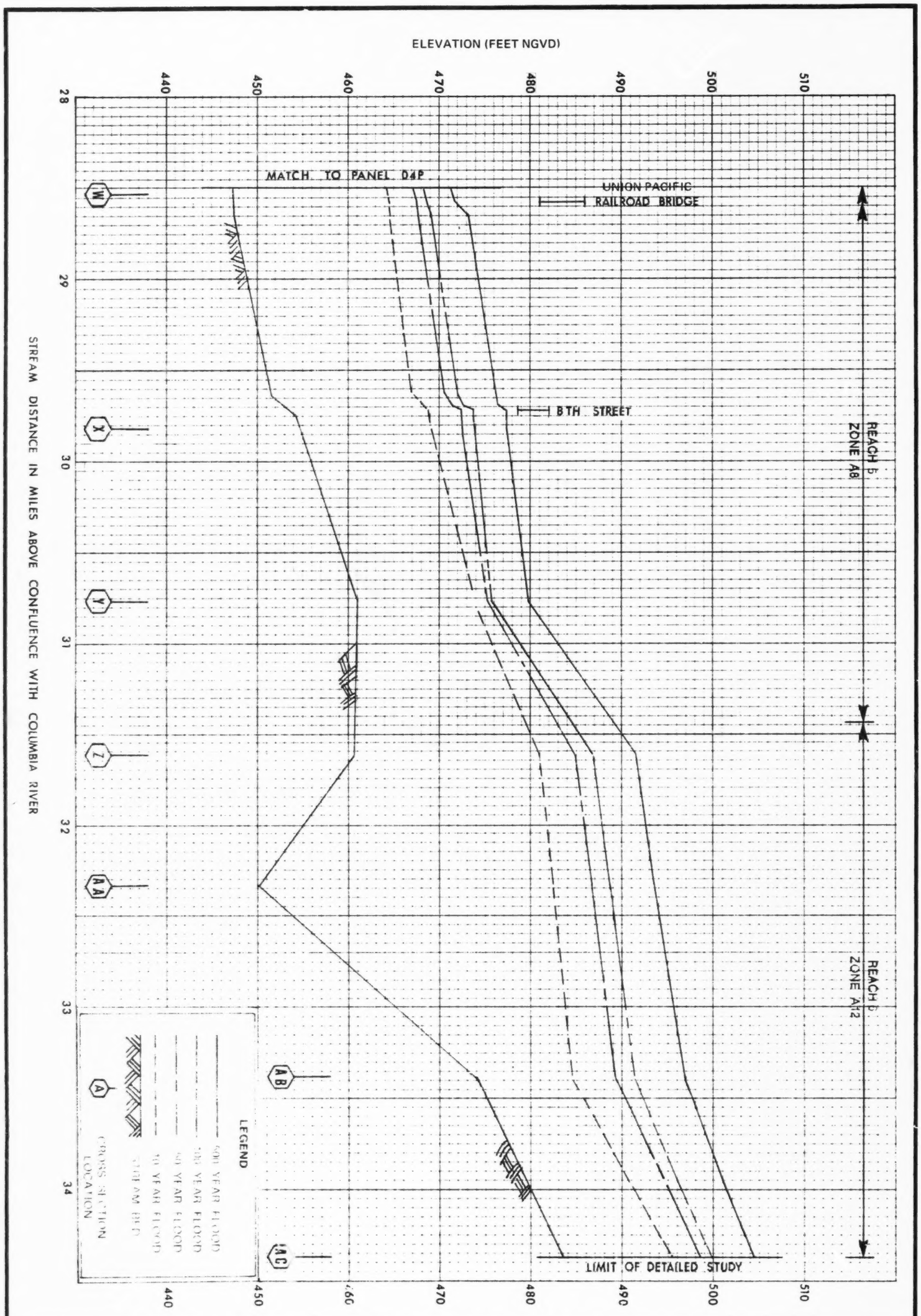



FLOOD PROFILES

YAKIMA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
BENTON COUNTY, WA
(UNINCORPORATED AREAS)

04P

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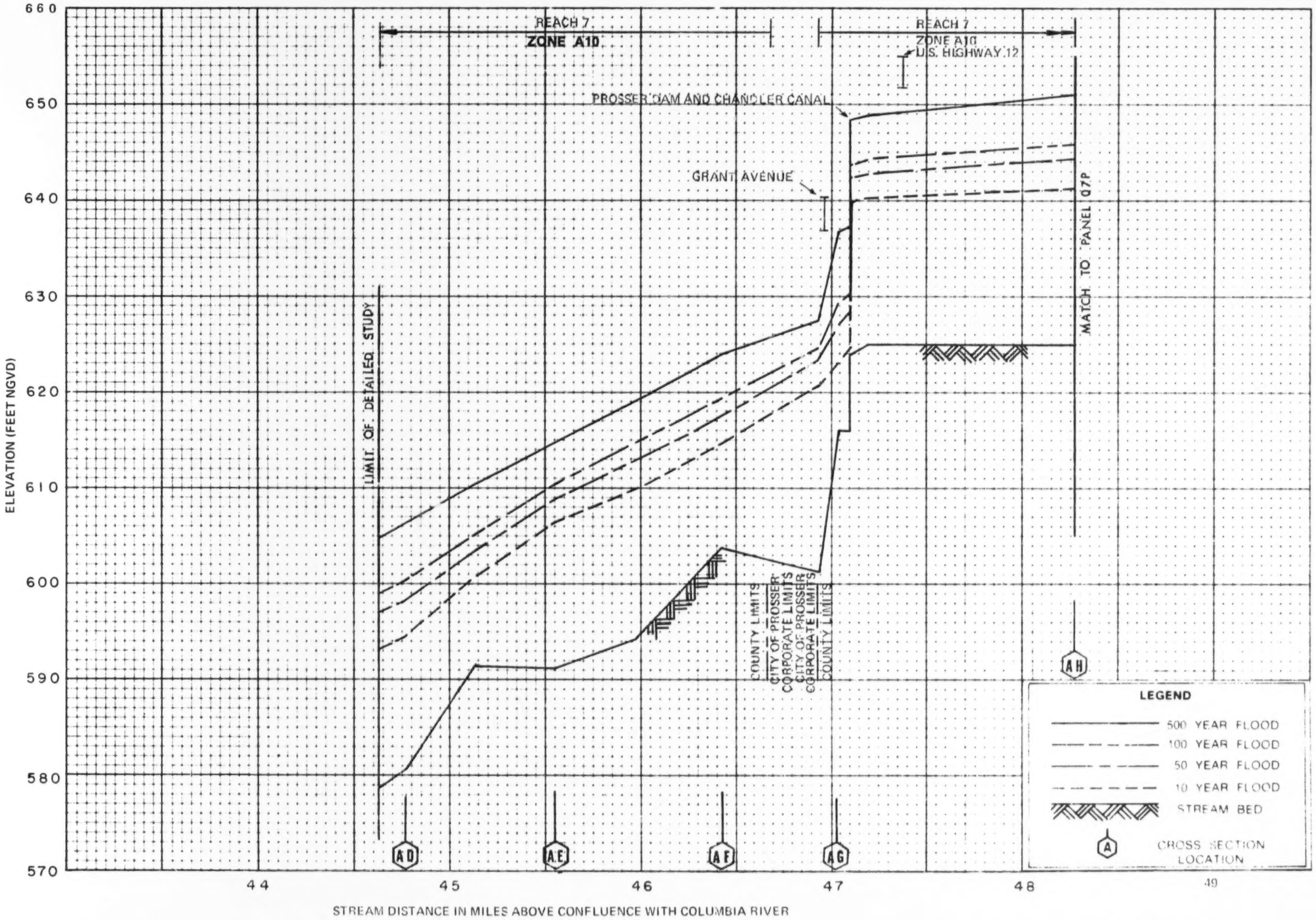
05P

FEDERAL EMERGENCY MANAGEMENT AGENCY
BENTON COUNTY, WA
(UNINCORPORATED AREAS)

**FLOOD PROFILES**

**YAKIMA RIVER**




FLOOD PROFILES

YAKIMA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
BENTON COUNTY, WA
(UNINCORPORATED AREAS)

06P

REACH 7

ZONE A1D

ELEVATION (FEET NGVD)

670
660
650
640
630
620
610
600
590

MATCH LINE TO PANEL 06P

BENTON CO. LINE

YAKIMA CO. LINE

LIMIT OF STUDY

AH AI AJ AK AL

48 49 50 51 52

STREAM DISTANCE IN MILES ABOVE CONFLUENCE WITH COLUMBIA RIVER

LEGEND

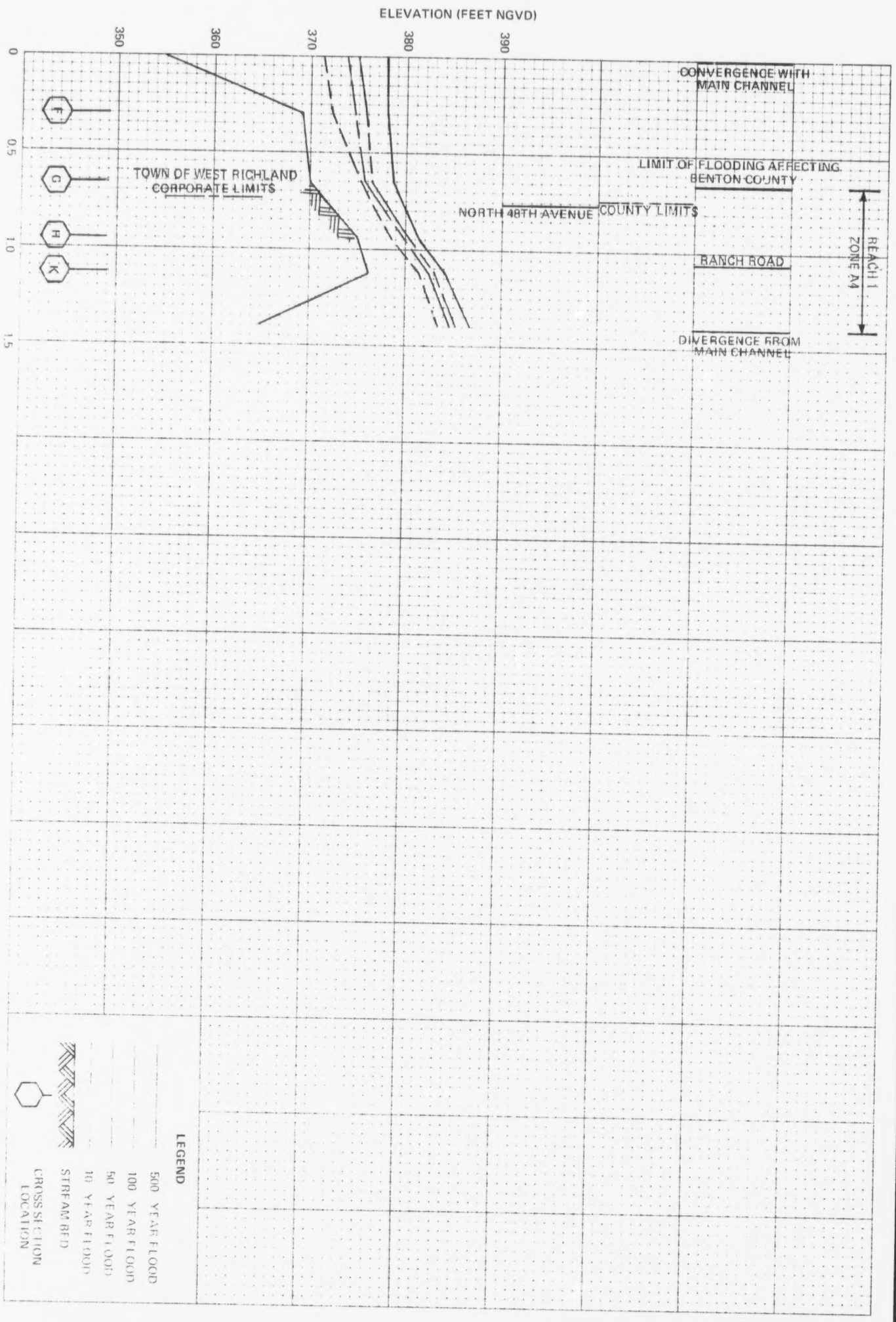
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
A CROSS SECTION LOCATION

**FLOOD PROFILES**

**YAKIMA RIVER**

FEDERAL EMERGENCY MANAGEMENT AGENCY
**BENTON COUNTY, WA**
**(UNINCORPORATED AREAS)**

**07P**

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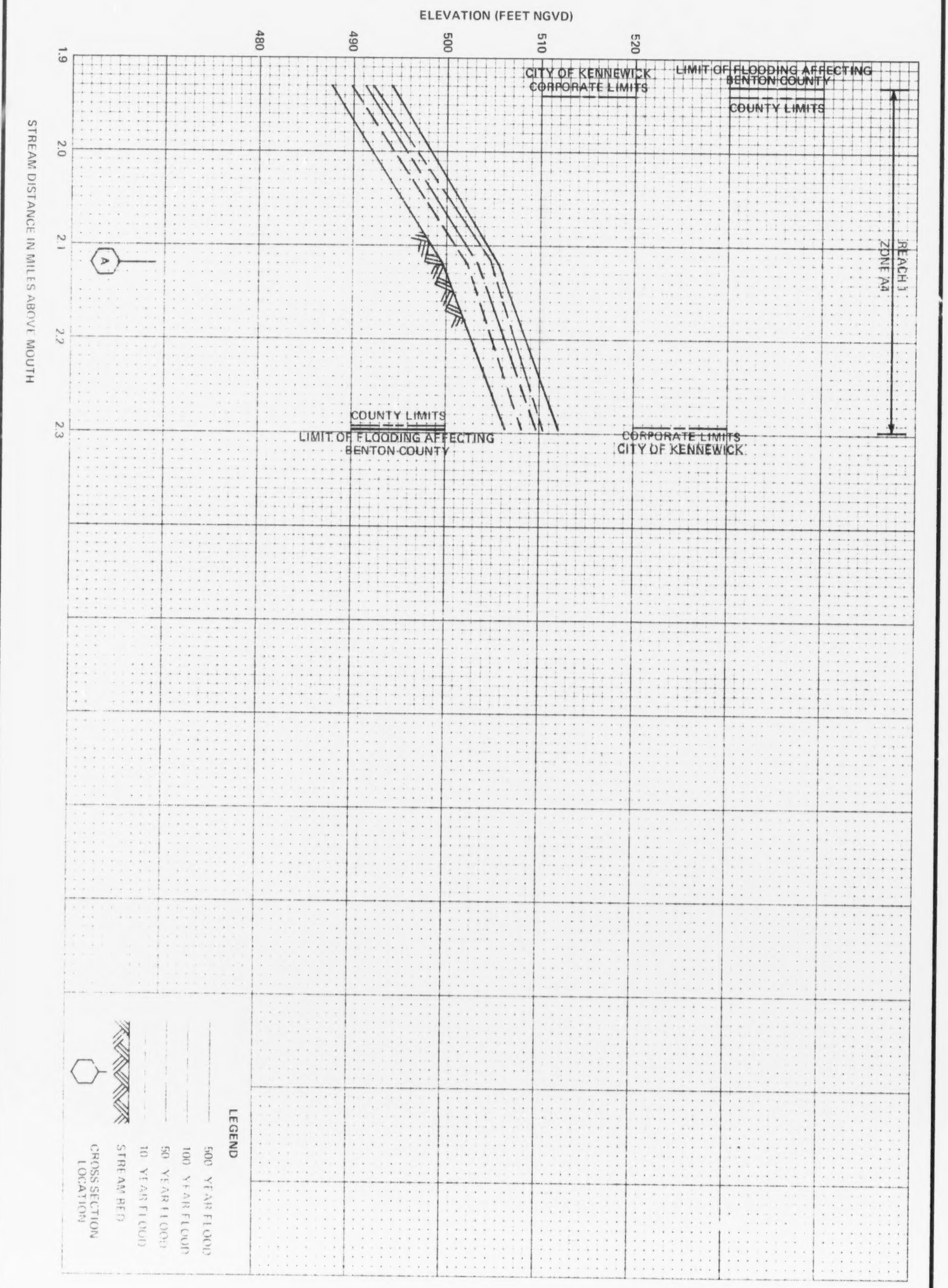
| 08P | FEDERAL EMERGENCY MANAGEMENT AGENCY<br>**BENTON COUNTY, WA**<br>(UNINCORPORATED AREAS) | **FLOOD PROFILES**<br>**YAKIMA RIVER-RIGHT OVERBANK** |
|---|---|---|



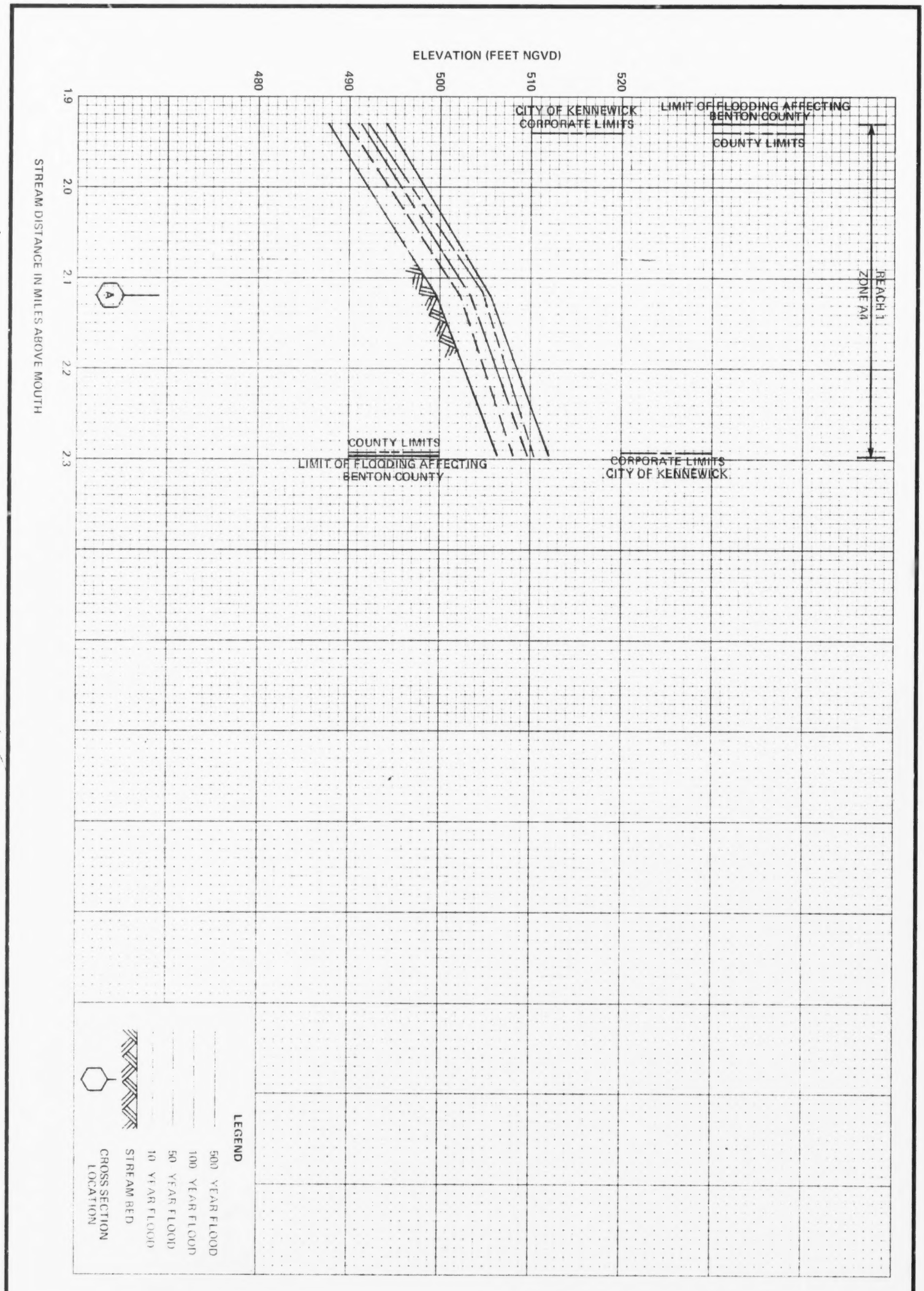

FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
**(UNINCORPORATED AREAS)**

**FLOOD PROFILES**

**ZINTEL CANYON**

**060P**




FEDERAL EMERGENCY MANAGEMENT AGENCY

**BENTON COUNTY, WA**
**(UNINCORPORATED AREAS)**

**FLOOD PROFILES**

**ZINTEL CANYON**

09P